TITLE OF INVENTION

SENSOR

BACKGROUND OF INVENTION

[0001] This Nonprovisional application claims priority under 35 U.S.C. § 119(a) on patent Application No. 2002-333704 filed in Japan on November 18,2002, the entire contents of which are hereby incorporated by reference.

[0002] The present invention pertains to a sensor detecting entry of object(s) into overlapping zone(s) at which projected light optical path(s) of light irradiated from light-projecting component(s) overlap received light optical path(s) of light incident on light-receiving component(s).

[0003] Conventional sensors include automatic door sensors having the ability to vary the protected zone for detection of persons traveling therethrough, as disclosed for example at Japanese Patent Application Publication Kokai No. H3-55381 (1991).

[0004] In this automatic door sensor, a light-projecting component and a light-receiving component are disposed above an automatic door. A two-piece rotatable mirror is employed as reflecting mirror to reflect light irradiated from the light-projecting component, the reflecting mirror splitting the light irradiated from the light-projecting component into two

beams which irradiate the floor, forming a first zone proximate to the door, and a second zone which is removed from this first zone. Furthermore, provided at the light-receiving component on which reflected light from this first zone and this second zone is incident there is a two-piece rotatable reflecting mirror, reflected light beams from the first zone and the second zone being respectively received by the light-receiving component.

[0005] In this automatic door sensor, because the light-projecting and light-receiving components respectively employ rotatable reflecting mirrors, it is possible through adjustment of the rotational angles of these reflecting mirrors to simultaneously relocate the first zone and the second zone.

[0006] Now, it is generally the case with automatic door sensors that the density of the light irradiated from the light-projecting component will be highest near the automatic door sensor, and will decrease as one goes outside of that region and approaches regions peripheral thereto. Furthermore, if the distance between the light-projecting component and the light-receiving component arranged therein is varied, then, holding the density of the light irradiated from the light-projecting component constant, the density of the light irradiated from the light-projecting component will decrease as the distance between the two is increased.

[0007] Using the automatic door sensor disclosed at Japanese Patent Application Publication Kokai No. H3-55381 (1991) as an example to illustrate this fact, the optical path length of the light beam arriving at the light-receiving component after reflection from the (peripheral) second zone will be longer than that of the light beam arriving at the light-receiving component after reflection from the first zone (near the light-projecting component). For this reason, while it is possible with this automatic door sensor to vary protected zones so as to form arbitrary protected zones (first zone(s) and second zone(s)), it is not possible to carry out detection of objects entering protected zones such that equivalent light density, i.e., optical sensitivity, is used for detection thereof across all protected zones. For this reason, taking detection in the first zone as reference, it will sometimes be the case that the low light density and low optical sensitivity in the second zone will prevent detection thereat. Or taking

detection in the second zone as reference, the high light density and high optical sensitivity in the first zone will sometimes cause faulty operation such that objects not intended for detection, e.g., paper lying on the ground or the like, are detected thereat.

[0008] In order to solve one or more of the aforementioned problems, it is therefore an object of the present invention to provide a sensor having ability to vary protected zone(s) at which detection of person(s) traveling therethrough and/or other such object(s) are detected and carrying out detection of object(s) entering protected zone(s) such that detection thereof is carried out with equivalent optical sensitivity across all protected zones despite any varying of protected zone(s).

SUMMARY OF INVENTION

[0009] In order to achieve the foregoing object and/or other objects, a sensor associated with one or more embodiments of the present invention comprises one or more light-projecting components irradiating light from one or more light-projecting surfaces; and one or more light-receiving components receiving at least a portion of the light irradiated from at least one of the light-projecting component or components, the received light being incident on one or more light-receiving surfaces after having been reflected; the sensor detecting one or more objects in one or more overlapping zones at which at least one projected light optical path of the light irradiated by at least one of the light-projecting component or components at least partially overlaps at least one received light optical path of the light incident on at least one of the light-receiving component or components; the sensor further comprising one or more optical path varying means varying at least one of the projected light optical path or paths and/or at least one of the received light optical path or paths so as to physically vary at least one of the overlapping zone or zones; at least one of the optical path varying means carrying out adjustment of optical sensitivity by increasing at least one extent of at least one of the overlapping zone or zones when carrying out detection with respect to at least one distant

zone and/or decreasing at least one extent of at least one of the overlapping zone or zones when carrying out detection with respect to at least one proximate zone.

[0010] In accordance with such embodiment(s) of the present invention, because optical path varying means is/are provided, adjustment of optical sensitivity may be carried out by increasing extent(s) of overlapping zone(s) when carrying out detection with respect to zone(s) distant from such sensor(s) and/or decreasing extent(s) of overlapping zone(s) when carrying out detection with respect to zone(s) proximate to such sensor(s). That is, because light density is high when carrying out detection with respect to zone(s) proximate to such sensor(s), adjustment of optical sensitivity may be carried out so as to decrease extent(s) of overlapping zone(s); and because light density is low when carrying out detection with respect to zone(s) distant from such sensor(s), adjustment of optical sensitivity may be carried out so as to increase extent(s) of overlapping zone(s). As a result, it will be possible to carry out detection of object(s) entering overlapping zone(s) such that detection thereof is carried out with equivalent optical sensitivity across all overlapping zones despite any varying of overlapping zone(s).

[0011] Furthermore, because optical path varying means may physically vary overlapping zone(s), it is possible to reduce manufacturing cost as compared with the alternative of electrically varying same, as there is no need to develop and provide additional controller(s) for varying overlapping zone(s).

[0012] More specifically, in the foregoing constitution, at least one of the optical path varying means may be such that one or more translucent curved bodies is or are disposed in at least one of the projected and/or received light optical path or paths; at least one of the translucent curved body or bodies comprises one or more flat components and one or more curved components formed in continuous fashion; at least one of the light-projecting component or components and at least one of the light-receiving component or components are arrayed in the same order as at least one of the flat component or components and at least one of the curved component or components formed in continuous fashion; and when

carrying out detection with respect to at least one distant zone, at least one of the light-projecting component or components and at least one of the light-receiving component or components are made to move and/or rotate from at least one of the flat component or components and toward at least one of the curved component or components while maintaining at least one distance between at least a portion of the light-projecting and light-receiving surfaces of the light-projecting and light-receiving components.

[0013] Alternatively or in addition thereto, at least one of the optical path varying means may be such that one or more prismatic bodies is or are disposed in at least one of the projected and/or received light optical path or paths; at least one of the prismatic body or bodies presenting gradually increasing angle or angles as one goes from at least one side thereof to at least one other side thereof; at least one of the light-projecting component or components and at least one of the light-receiving component or components are arrayed in the same order as the at least one side thereof and the at least one other side thereof; and when carrying out detection with respect to at least one distant zone, at least one of the light-projecting component or components and at least one of the light-receiving component or components are made to move and/or rotate from the at least one side thereof and toward the at least one other side thereof while maintaining at least one distance between at least a portion of the light-projecting and light-receiving surfaces of the light-projecting and light-receiving components.

[0014] Alternatively or in addition thereto, at least one of the optical path varying means may be such that one or more mirror bodies is or are disposed in at least one of the projected and/or received light optical path or paths; at least one of the mirror body or bodies comprises one or more flat components and one or more curved components formed in continuous fashion; at least one of the light-projecting component or components and at least one of the light-receiving component or components are arrayed in the same order as at least one of the flat component or components and at least one of the curved component or components formed in continuous fashion; and when carrying out detection with respect to at least one

distant zone, at least one of the light-projecting component or components and at least one of the light-receiving component or components are made to move and/or rotate from at least one of the flat component or components and toward at least one of the curved component or components while maintaining at least one distance between at least a portion of the light-projecting and light-receiving surfaces of the light-projecting and light-receiving components.

[0015] Alternatively or in addition thereto, at least one of the optical path varying means may be such that one or more rotatable shafts for rotating at least one of the light-projecting component or components and at least one of the light-receiving component or components is or are disposed between at least one of the light-projecting component or components and at least one of the light-receiving component or components; and when carrying out detection with respect to at least one distant zone, at least one of the light-projecting component or components and/or at least one of the light-receiving component or components is or are rotated in at least one direction such as would tend to increase the degree to which at least one of the light-projecting surface or surfaces faces at least one of the light-receiving surface or surfaces.

[0016] Adoption of the foregoing specific optical path varying means constitution(s) makes it possible to eliminate the need to provide additional member(s) that might be arranged therein only with difficulty. As a result, it is possible to reduce sensor parts count and/or simplify sensor structure.

BRIEF DESCRIPTION OF DRAWINGS

[0017] FIG. 1 (a) is a schematic diagram of the principal parts of a sensor associated with a first embodiment, shown at a time when detection is being carried out with respect to a proximate zone. FIG. 1 (b) is a schematic diagram of the principal parts of the sensor, shown at a time when detection is being carried out with respect to a distant zone.

[0018] FIG. 2 (a) is a schematic diagram of the principal parts of a sensor associated with a second embodiment, shown at a time when detection is being carried out with respect to a proximate zone. FIG. 2 (b) is a schematic diagram of the principal parts of the sensor, shown at a time when detection is being carried out with respect to a distant zone.

[0019] FIG. 3 (a) is a schematic diagram of the principal parts of a sensor associated with a third embodiment, shown at a time when detection is being carried out with respect to a proximate zone. FIG. 3 (b) is a schematic diagram of the principal parts of the sensor, shown at a time when detection is being carried out with respect to a distant zone.

[0020] FIG. 4 (a) is a schematic diagram of the principal parts of a sensor associated with a fourth embodiment, shown at a time when detection is being carried out with respect to a proximate zone. FIG. 4 (b) is a schematic diagram of the principal parts of the sensor, shown at a time when detection is being carried out with respect to a distant zone.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0021] Below, embodiments of the present invention are described with reference to the drawings. Note that while the following embodiments apply the present invention to an automatic door sensor, this being one type of sensor, the present invention is not limited thereto, it being possible to apply the present invention to sensors used in other fields, e.g., security sensors and the like.

[0022] FIRST EMBODIMENT

As shown in FIG. 1, automatic door sensor 1 is such that light-projecting component(s) 11, irradiating light from light-projecting surface(s) 111; and light-receiving component(s) 12, receiving light irradiated from such light-projecting component(s) 11, the received light being incident on light-receiving surface(s) 121 after having been reflected, are arrayed vertically at the time that this automatic door sensor 1 is installed. Furthermore, at this automatic door sensor 1, cover(s) is/are employed at housing surface(s) facing light-projecting and light-

receiving surfaces 111, 121 for allowing light to be irradiated from light-projecting component 11 and incident on light-receiving component 12. Note also that detection conditions are such that constant density is maintained in the light irradiated from light-projecting surface 111 of light-projecting component 11.

[0023] In accordance with such constitution, this automatic door sensor 1 is such that object(s) is/are detected at overlapping zone(s) 16 at which projected light optical path(s) 14 of light irradiated from light-projecting component(s) 11 and transmitted through cover(s) overlaps received light optical path(s) 15 of light transmitted through cover(s) and incident on light-receiving component(s) 12.

[0024] Furthermore, such automatic door sensor 1 may be provided with optical path varying means varying projected light optical path(s) 14 and/or received light optical path(s) 15 so as to physically vary overlapping zone(s) 16. Such optical path varying means may carry out adjustment of optical sensitivity by increasing extent(s) of overlapping zone(s) 16 (see FIG. 1 (b)) when carrying out detection with respect to zone(s) distant from the automatic door sensor 1 and/or decreasing extent(s) of overlapping zone(s) (see FIG. 1 (a)) when carrying out detection with respect to zone(s) proximate to the automatic door sensor 1.

[0025] As shown in FIG. 1, the present optical path varying means is such that translucent curved body 13 is disposed in projected and received light optical paths 14, 15, the translucent curved body 13 comprising flat component 131 and curved component 132 formed in continuous fashion. Furthermore, light-projecting component 11 and light-receiving component 12 are arrayed such that light-projecting component 11 is on the same side as flat component 131 of translucent curved body 13, and light-receiving component 12 is on the same side as curved component 132 thereof. Moreover, when carrying out detection with respect to zone(s) distant from this automatic door sensor 1, light-projecting and light-receiving surfaces 111, 121 of light-projecting and light-receiving components 11, 12 are rotated from flat component 131 of translucent curved body 13 toward curved component 132 thereof while maintaining the distance between light-projecting and light-receiving

surfaces 111, 121 of light-projecting and light-receiving components 11, 12. Note that this translucent curved body 13 may also be employed as the translucent cover which is the housing of this automatic door sensor 1.

[0026] Next, referring to FIG. 1, operation of automatic door sensor 1 when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1 and operation thereof when carrying out detection with respect to a zone which is distant from this automatic door sensor 1 will be described.

[0027] First, when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are both disposed so as to cause light-projecting and light-receiving surfaces 111, 121 to be directed toward flat component 131 of translucent curved body 13.

[0028] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14 and is transmitted through flat component 131. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is transmitted through translucent curved body 13 and is incident on light-receiving surface 121, being received by light-receiving component 12. As shown at FIG. 1 (a), the extent of overlapping zone 16 at this time is small.

[0029] Next, when carrying out detection with respect to a zone which is distant from this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are both rotated from flat component 131 of translucent curved body 13 toward curved component 132 thereof. At such time, light-receiving surface 121 of light-receiving component 12 is disposed so as to be directed at curved component 132, and light-projecting surface 111 of light-projecting component 11 is disposed so as to be directed at flat component 131.

[0030] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14 and is transmitted through flat component 131. Of this

irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is transmitted through translucent curved body 13 and is incident on light-receiving surface 121, being received by light-receiving component 12. At such time, the light incident thereat being refracted by curved component 132, the received light optical path 15 undergoes refraction as indicated at FIG. 1 (b). Furthermore, as shown at FIG. 1 (b), the extent of overlapping zone 16 at this time is large.

[0031] As described above, in accordance with the present automatic door sensor 1, because translucent curved body 13 is provided, adjustment of optical sensitivity may be carried out by increasing extent(s) of overlapping zone(s) 16 when carrying out detection with respect to zone(s) distant from this automatic door sensor 1 and/or decreasing extent(s) of overlapping zone(s) 16 when carrying out detection with respect to zone(s) proximate to this automatic door sensor 1. That is, because light density is high when carrying out detection with respect to zone(s) proximate to this automatic door sensor 1, adjustment of optical sensitivity may be carried out so as to decrease extent(s) of overlapping zone(s) 16; and because light density is low when carrying out detection with respect to zone(s) distant from this automatic door sensor 1, adjustment of optical sensitivity may be carried out so as to increase extent(s) of overlapping zone(s) 16. As a result, it will be possible to carry out detection of object(s) entering overlapping zone(s) 16 such that detection thereof is carried out with equivalent optical sensitivity across all overlapping zones 16 despite any varying of overlapping zone(s) 16.

[0032] Furthermore, because translucent curved body 13 physically varies overlapping zone(s) 16, it is possible to reduce manufacturing cost as compared with the alternative of electrically varying same, as there is no need to develop and provide additional controller(s) for varying overlapping zone(s) 16.

[0033] Furthermore, because translucent curved body 13 is provided therein, this automatic door sensor 1 makes it possible to eliminate the need to provide additional member(s) that might be arranged therein only with difficulty. As a result, it is possible to reduce the parts count of automatic door sensor 1 and/or simplify the structure of automatic door sensor 1.

[0034] Note also that whereas in the present first embodiment translucent curved body 13 is employed as the cover which is the housing of automatic door sensor 1, the present invention is not limited thereto; it being possible, for example, to separately provide same at the interior of the housing, provided only that same be disposed in projected and/or received light optical paths 14, 15.

[0035] Furthermore, whereas translucent curved body 13 was disposed in projected and received light optical paths 14, 15, the present invention is not limited thereto; it being possible, for example, to dispose translucent curved body 13 only in projected light optical path 14, varying extent(s) of overlapping zone(s) 16 by refracting only projected light optical path 14.

[0036] Furthermore, whereas light-projecting component 11 and light-receiving component 12 were arrayed such that light-projecting component 11 was on the same side as flat component 131 of translucent curved body 13, and light-receiving component 12 was on the same side as curved component 132 thereof, the present invention is not limited thereto; it being possible, for example, for light-projecting component 11 and light-receiving component 12 to be arrayed such that light-receiving component 12 is on the same side as flat component 131 of translucent curved body 13, and light-projecting component 11 is on the same side as curved component 132 thereof.

[0037] Furthermore, whereas light-projecting component 11 and light-receiving component 12 were arrayed vertically at the time that automatic door sensor 1 was installed, the present invention is not limited thereto; it being possible, for example, to array same horizontally, provided only that light-projecting component 11 and light-receiving component 12 are rotated from flat component 131 of translucent curved body 13 toward curved component

132 thereof while maintaining the distance between light-projecting and light-receiving surfaces 111, 121 of light-projecting and light-receiving components 11, 12.

[0038] Furthermore, whereas light-projecting component 11 and light-receiving component 12 were rotated from flat component 131 of translucent curved body 13 toward curved component 132 thereof, the present invention is not limited thereto; it being possible for light-projecting component 11 and light-receiving component 12 to be moved from flat component 131 of translucent curved body 13 toward curved component 132.

[0039] Next, automatic door sensors associated with other embodiments having operation and effect similar to automatic door sensor 1 associated with the present first embodiment will be described.

[0040] SECOND EMBODIMENT

The automatic door sensor of the second embodiment differs from the automatic door sensor of the foregoing first embodiment only with respect to the optical path varying means, the constitutions thereof being identical in other respects. Description of the present second embodiment will therefore be confined to the optical path varying means with respect to which it differs from the automatic door sensor of the first embodiment, and like constituents will be assigned like reference numerals and description thereof will be omitted.

[0041] As shown in FIG. 2, arranged at automatic door sensor 1 there are light-projecting component 11 and light-receiving component 12, cover(s) being employed at housing surface(s) facing light-projecting and light-receiving surfaces 111, 121 of these light-projecting and light-receiving components 11, 12. Note also that detection conditions are such that constant density is maintained in the light irradiated from light-projecting surface 111 of light-projecting component 11.

[0042] Furthermore, such automatic door sensor 1 may be provided with optical path varying means varying projected light optical path(s) 14 and/or received light optical path(s) 15 so as to physically vary overlapping zone(s) 16.

[0043] As shown in FIG. 2, the present optical path varying means is such that prismatic body 23 is disposed in projected and received light optical paths 14, 15, the prismatic body 23 presenting gradually increasing angles as one goes from one side 231 thereof to the other side 232 thereof. Furthermore, light-projecting component 11 and light-receiving component 12 are arrayed in the order "light-projecting component 11 to light-receiving component 12" as one goes from the one side 231 thereof to the other side 232 thereof. Moreover, when carrying out detection with respect to zone(s) distant from this automatic door sensor 1, light-projecting and light-receiving surfaces 111, 121 of light-projecting and light-receiving components 11, 12 are rotated from the one side 231 of prismatic body 23 to the other side 232 thereof while maintaining the distance between light-projecting and light-receiving surfaces 111, 121 of light-projecting and light-receiving components 11, 12. Note that this prismatic body 23 may also be employed as the translucent cover which is the housing of this automatic door sensor 1.

[0044] Next, referring to FIG. 2, operation of automatic door sensor 1 when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1 and operation thereof when carrying out detection with respect to a zone which is distant from this automatic door sensor 1 will be described.

[0045] First, when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1, light-projecting component 11 and light-receiving component 12 are disposed so as to cause light-projecting and light-receiving surfaces 111, 121 to be directed toward prismatic body 23 in the order "light-projecting component 11 to light-receiving component 12" as one goes from the one side 231 of prismatic body 23 to the other side 232 thereof.

[0046] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14 and is transmitted through prismatic body 23. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14

overlaps received light optical path 15—is reflected. This reflected light is transmitted through prismatic body 23 and is incident on light-receiving surface 121, being received by light-receiving component 12 (see FIG. 2 (a)).

[0047] Next, when carrying out detection with respect to a zone which is distant from this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are both rotated from the one side 231 of prismatic body 23 to the other side 232 thereof. At such time, light-receiving surface 121 of light-receiving component 12 is disposed so as to be directed at certain angular part(s) 23a of prismatic body 23, and light-projecting surface 111 of light-projecting component 11 is disposed so as to be directed at certain nonangular part(s) 23b of prismatic body 23 (see FIG. 2 (b)).

[0048] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14 and is transmitted through prismatic body 23. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is transmitted through prismatic body 23 and is incident on light-receiving surface 121, being received by light-receiving component 12. At such time, the light incident thereat being refracted by prismatic body 23, the received light optical path 15 undergoes refraction as indicated at FIG. 2 (b).

[0049] THIRD EMBODIMENT

The automatic door sensor of the third embodiment differs from the automatic door sensor of the foregoing first embodiment only with respect to the optical path varying means, the constitutions thereof being identical in other respects. Description of the present third embodiment will therefore be confined to the optical path varying means with respect to which it differs from the automatic door sensor of the first embodiment, and like constituents will be assigned like reference numerals and description thereof will be omitted.

[0050] As shown in FIG. 3, arranged at automatic door sensor 1 there are light-projecting component 11 and light-receiving component 12. Note also that detection conditions are such that constant density is maintained in the light irradiated from light-projecting surface 111 of light-projecting component 11.

[0051] Furthermore, such automatic door sensor 1 may be provided with optical path varying means varying projected light optical path(s) 14 and/or received light optical path(s) 15 so as to physically vary overlapping zone(s) 16.

[0052] As shown in FIG. 3, the present optical path varying means is such that mirror 33 is disposed in projected and received light optical paths 14, 15, the mirror 33 comprising flat component 331 and curved component 332 formed in continuous fashion. Furthermore, light-projecting component 11 and light-receiving component 12 are arrayed such that light-projecting component 11 is on the same side as flat component 331 of mirror 33, and light-receiving component 12 is on the same side as curved component 332 thereof. Moreover, when carrying out detection with respect to zone(s) distant from this automatic door sensor 1, light-projecting and light-receiving surfaces 111, 121 of light-projecting and light-receiving components 11, 12 are rotated from flat component 331 of mirror 33 toward curved component 332 thereof while maintaining the distance between light-projecting and light-receiving surfaces 111, 121 of light-projecting and light-receiving components 11, 12.

[0053] Next, referring to FIG. 3, operation of automatic door sensor 1 when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1 and operation thereof when carrying out detection with respect to a zone which is distant from this automatic door sensor 1 will be described.

[0054] First, when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1, light-projecting component 11 and light-receiving component 12 are disposed so as to cause light-projecting and light-receiving surfaces 111, 121 to be directed toward mirror 33 in the order "light-projecting component 11 to light-receiving component

12" as one goes from the flat component 331 side of mirror 33 to the curved component 332 side thereof.

[0055] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14 and is reflected by mirror 33. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is reflected by mirror 33 and is incident on light-receiving surface 121, being received by light-receiving component 12 (see FIG. 3 (a)).

[0056] Next, when carrying out detection with respect to a zone which is distant from this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are both rotated from flat component 331 of mirror 33 toward curved component 332 thereof. At such time, light-receiving surface 121 of light-receiving component 12 is disposed so as to be directed at the curved component 332 side of mirror 33, and light-projecting surface 111 of light-projecting component 11 is disposed so as to be directed at the flat component 331 side of mirror 33 (see FIG. 3 (b)).

[0057] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14 and is reflected by mirror 33. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is reflected by mirror 33 and is incident on light-receiving surface 121, being received by light-receiving component 12. At such time, the light incident thereat being altered by mirror 33, the received light optical path 15 undergoes alteration as indicated at FIG. 3 (b).

[0058] FOURTH EMBODIMENT

The automatic door sensor of the fourth embodiment differs from the automatic door sensor of the foregoing first embodiment only with respect to the optical path varying means, the

constitutions thereof being identical in other respects. Description of the present fourth embodiment will therefore be confined to the optical path varying means with respect to which it differs from the automatic door sensor of the first embodiment, and like constituents will be assigned like reference numerals and description thereof will be omitted.

[0059] As shown in FIG. 4, arranged at automatic door sensor 1 there are light-projecting component 11 and light-receiving component 12. Note also that detection conditions are such that constant density is maintained in the light irradiated from light-projecting surface 111 of light-projecting component 11.

[0060] Furthermore, such automatic door sensor 1 may be provided with optical path varying means varying projected light optical path(s) 14 and/or received light optical path(s) 15 so as to physically vary overlapping zone(s) 16.

[0061] As shown in FIG. 4, the present optical path varying means is such that rotatable shaft 43 for rotating light-projecting component 11 and light-receiving component 12 is disposed between light-projecting component 11 and light-receiving component 12. Moreover, when carrying out detection with respect to zone(s) distant from this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are rotated in the same direction (counterclockwise at FIG. 4 (a)), with rotatable shaft 43 serving as axis of rotation; and furthermore, light-projecting and light-receiving components 11, 12 are both rotated in directions such as would tend to increase the degree to which light-projecting surface 111 and light-receiving surface 121 face each other.

[0062] Next, referring to FIG. 4, operation of automatic door sensor 1 when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1 and operation thereof when carrying out detection with respect to a zone which is distant from this automatic door sensor 1 will be described.

[0063] First, when carrying out detection with respect to a zone which is proximate to this automatic door sensor 1, light-projecting component 11 and light-receiving component 12 are

disposed so as to cause light-projecting and light-receiving surfaces 111, 121 to face the same direction.

[0064] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is incident on light-receiving surface 121, being received by light-receiving component 12 (see FIG. 4 (a)).

[0065] Next, when carrying out detection with respect to a zone which is distant from this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are rotated in the same direction, with rotatable shaft 43 serving as axis of rotation (see rotatable shaft 43 at FIG. 4 (a)); and furthermore, light-projecting and light-receiving components 11, 12 are both rotated in directions such as would tend to increase the degree to which light-projecting and light-receiving surfaces 111, 121 face each other (see FIG. 4 (b)).

[0066] With the sensor in this state, light irradiated from light-projecting component 11 follows projected light optical path 14. As shown at FIG. 4 (b), the irradiated light at this time is such that projected light optical path 14 is formed in a direction such as will bring it toward received light optical path 15. Of this irradiated light, only that portion irradiated along received light optical path 15, i.e., only that portion which irradiates overlapping zone 16—at which projected light optical path 14 overlaps received light optical path 15—is reflected. This reflected light is incident on the light-receiving surface, being received by light-receiving component 12 (see FIG. 4 (b)).

[0067] Note also that whereas in the present fourth embodiment when carrying out detection with respect to zone(s) distant from this automatic door sensor 1, light-projecting and light-receiving components 11, 12 are by means of rotatable shaft 43 both rotated in directions such as would tend to increase the degree to which light-projecting surface 111 and light-

receiving surface 121 face each other, the present invention is not limited thereto; it being possible to rotate only either light-projecting component 11 or light-receiving component 12.

[0068] As described above with reference to the foregoing first through fourth embodiments, sensors in accordance with embodiment(s) of the present invention make it possible to vary protected zone(s) at which detection of person(s) traveling therethrough and/or other such object(s) are detected and make it possible to carry out detection of object(s) entering protected zone(s) such that detection thereof is carried out with equivalent sensitivity with respect to projected and/or received light across all protected zones despite any varying of protected zone(s).

[0069] That is, with sensors in accordance with embodiment(s) of the present invention, because optical path varying means may be provided, adjustment of sensitivity with respect to projected and/or received light may be carried out by increasing extent(s) of overlapping zone(s) when carrying out detection with respect to distant zone(s) and/or decreasing extent(s) of overlapping zone(s) when carrying out detection with respect to proximate zone(s). That is, because light density is high when carrying out detection with respect to zone(s) proximate to such sensor(s), adjustment of optical sensitivity may be carried out so as to decrease extent(s) of overlapping zone(s); and because light density is low when carrying out detection with respect to zone(s) distant from such sensor(s), adjustment of optical sensitivity may be carried out so as to increase extent(s) of overlapping zone(s). As a result, it will be possible to carry out detection of object(s) entering overlapping zone(s) such that detection thereof is carried out with equivalent sensitivity with respect to projected and/or received light across all overlapping zones despite any varying of overlapping zone(s).

[0070] Furthermore, because optical path varying means may physically vary overlapping zone(s), it is possible to reduce manufacturing cost as compared with the alternative of electrically varying same, as there is no need to develop and provide additional controller(s) for varying overlapping zone(s).

[0071] Furthermore, it is possible to eliminate the need to provide additional member(s) that might be arranged therein only with difficulty. As a result, it is possible to reduce sensor parts count and/or simplify sensor structure.